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Fire Management Notes

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An international quarterly periodical devoted to forest fire management

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Contents

Cover: Forest ranger C. P. Cockrell using a map and compass to measure distance to forest fire—Kootenai National Forest, MT, 1927.

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Use of Fire Plows in a Marsh [1]

Dale L. Taylor and Regina Rochefort Gibbons

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Many knowledgeable people believe that the use of plow lines for fire suppression in the interior wetlands of south Florida is environmentally unacceptable. This study shows that plow lines change elevation to encompass the range of most plant communities, possibly disrupt mycorrhizal associations, and impact water flows. The nearly 700 miles of off-road vehicle trails that already exist within the preserve are a suggested alternative for use for fire suppression rather than plow lines. These recommendations for Big Cypress National Preserve may have application on other wetland areas.

Introduction

Forest fire suppression tactics in marsh areas frequently require a fire tractor and plow. The resulting plow lines are used for a fire break, or as a position from which a backfire is set. We feel the resulting plow lines have potential long-term impact upon the marsh ecosystem that has not been considered. Our example is from a National Park Service area, the Big Cypress National Preserve, in south Florida, but we feel there is application to other wetlands.

Plow lines impact soil resulting in succession by different plant communities than occurred on the undisturbed site. Plow lines create habitats for invasion of exotic plant species, and they impact drainage by lowering elevation in the furrow and raising elevation on the berm. In an area where small, high-speed off-road vehicles are allowed, plow lines can be a safety hazard.

A review of fire management in adjacent Everglades National Park shows that early attempts to use equipment were not considered successful because vehicles frequently broke down, got stuck, made deep tracks or bulldozer lines that scarred the landscape with plow lines that are still visible 30 years later (*5*). Since 1974, all vehicles in Everglades National Park have been restricted to established trails to minimize soil damage.

Even though the policies of Big Cypress National Preserve allow off-road vehicle use, and tracks scarring the landscape are common, fire equipment must be used with discretion. National Park Service fire management policies (*4*, chapter 2, exhibit 1, p. 3) state that "fire suppression methods used in the parks should be those causing the least resource damage, commensurate with effective control."

Vasievich and Wade (*6*, p. 5), in their discussion of the Big Cypress Swamp, state that equipment, such as large bulldozers, should be used sparingly because high maintenance costs result from harsh working conditions, and the environmental damage caused by such equipment is often greater and longer lasting than the effects of the fire itself. They stated that "many knowledgeable people believe that all plow lines in the interior wetlands of south Florida are environmentally unacceptable." Wade and others (*7*) state that certain fire suppression tactics result in long-term scars and changes in drainage.

Big Cypress Plow Lines

Measurements were made on plow lines made about 5 years ago in the Deep Lake Prairie of Big Cypress National Preserve (table 1). The lines are located 2 miles north of Wagon Wheel Road and 1 1/2 to 2 miles east of the junction of Wagon Wheel Road and Birdon Road. They run in a southwesterly direction.

The plow lines are 155 centimeters (61 inches) wide. A change of 28 centimeters (11 inches) occurred from the bottom of the furrow to the top of the berm. The furrow was 14 centimeters (5.5 inches) lower and the berm 14 centimeters (5.5 inches) higher than surrounding land. Species similarity was 59 percent between the furrow and the unplowed area. More

[1] The authors would like to thank Lance Gunderson, Dr. Bill Robertson, and Fred Dayhoff, who reviewed and commented on this article.

than three times as much biomass (grams dry weight per meter square) occurred on the unplowed area as occurred in the furrow (table 1).

Gunderson and others (1982) have shown the range in elevation for all plant communities in the Turner River area of Big Cypress to be less than 1 meter (39.4 inches), but most plant communities occurred within a change in elevation of 30 centimeters (11.8 inches). This is a range of change within the realm caused by plow lines.

Potential Disruption of Mycorrhizal Associations

Factors that affect mycorrhizal associations include water levels, plowing, and fire; however, no information exists on the effect of fire (*3*). Meador felt the key to mycorrhizal management was in water level control, with high water level preventing oxygen from penetrating to the soil, thus reducing or destroying the aerobic fungi.

Meador's studies of the plowed Hole-in-the-Donut of nearby Everglades National Park reveal that the original glades vegetation is being replaced by more complex ecosystems in which mycorrhizae play a role in plant nutrition. The nonmyocorrhizal species that occur within a sawgrass community are outcompeted by the mycorrhizal species in competition for nutrients. To redirect succession toward glades vegetation would require that the environment be modified through water or fire management so that mycorrhizal fungi could not survive, thus favoring glades species.

Plow lines used in fire suppression cause soil disturbance similar to that described by Meador. To mitigate impact from plowing, the line should be rehabilitated to a level where all soil would be below the normal water level, thus making the area unfavorable for mycorrhizae. Nevertheless, the disturbed soil would still influence plant succession (for photographic examples see Wade and others 1980, fig. 21, p. 27). Exotic species, such as *Shinus* and *Melaleuca*, that fit category 3 of mycorrhizal associations (mycorrhizal associations may or may not develop depending upon environmental conditions), would be favored on plow lines over native species, and new seed sources would be established for further exotic invasion. For a detailed discussion of seedling establishment by *Shinus* and *Melaleuca*, see Ewel (*2*) and Woodall (*8*).

Table 1—*Mean soil depth (measured from bedrock to the top of the soil) and mean vegetative characteristics on a 5-year-old plow line (M = meters)*

	Soil depth (cm)	Percent vegetative coverage	Number of species Herbs	Number of species Total	Grass height (cm)	Biomass (g/M^2)
Furrow	82	74	19	30	30	115
Center of berm	110	—	—	—	—	—
One M from plow line	102	—	—	—	—	—
Seven M from plow						

Disruption of Water Flow

Water flow through furrows may be much like flow through ORV tracks as measured by Duever, and others (*1*). These researchers speculated that the influence of off-road vehicle trails on drainage was essentially negligible in terms of overall hydrology. However, they found that relative flow velocity data clearly indicated that trail flows consistently had higher mean velocities than flows through adjacent undisturbed habitats. Flows also occurred in some trails at lower water levels than in surrounding habitats, and thus flows in the trails must also occur for longer periods during the year. These occurrences might reduce hydroperiods and aggravate dry season droughts to some extent.

Duever's group found detectable drainage effects were most likely where a well-worn trail crossed an extensive low area such as a marl marsh or dwarf cypress forest, and then intersected a canal or major strand. The chances of a plow line intersecting a strand are high when one considers that a 7.5-mile line, two plow lines wide, was made from L–28 north to L–28 extended canals during the Turner 10 Fire of 1981.

An alternative to plowing is available in the extensive ORV trail system in the preserve (fig. 1). According to Duever, and others (*1*), over 682 miles of trails existed in 1973. These were the trails that were sufficiently impacted to be visible on the 1:70,000 scale aerial photography (fig. 2), and others are known to exist. Knowledge of these trails and selection of trails appropriate for use as fire lines or for backfiring can provide an appropriate alternative to plowing in the Big Cypress National Preserve.

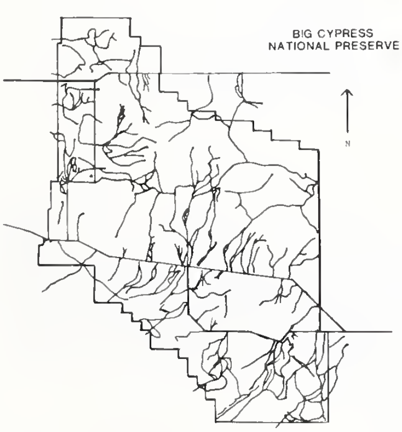

Figure 1.—*Portions of the 682-mile off-road vehicle trail in 1973. The asterisk indicates location of study plots. Big Cypress National Preserve is a 230,000-hectare reserve on the southwestern tip of south Florida. (Redrawn from Duever and others 1981).*

Figure 2.—*An example of off-road vehicle trails in the Big Cypress National Preserve. Photo was taken March 5, 1979, from an altitude of about 500 feet.*

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The ICS Planning Process

Paul Stimson and Jim Whitson

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One of the most positive features of the Incident Command System (ICS) is the formalized planning process that leads to the development of the incident action plan. This process, however, is probably one of the least understood aspects of the system. The purpose of this paper is to document the formalized planning process and to clarify the roles and responsibilities of those who participate in it.

The majority of emergencies that occur daily in the United States are handled by local agencies in their initial attack response. The initial attack incident commander, using knowledge, skill, and experience, will size up the incident, plan strategy, and make tactical assignments for the duration of the incident without a formal written plan. This process allows the incident commander (IC) to fill a number of roles, regulating command, operations, planning, logistics, and finance. In this process the IC usually transmits all instructions orally with no formal written documentation.

However, between 3 and 10 percent of all incidents become serious or complex enough to require a formal planning process leading to a written action plan. Describing the process leading to the formal incident action plan is the thrust of this paper.

For clarity the planning process is divided into three parts: Preplanning, planning meeting, and postplanning actions.

Preplanning

There are a number of actions that must be accomplished during this period, all of which lead to the planning meeting. If preplanning is not done in a timely and effective manner then the planning meeting will not progress smoothly. There are several roles and responsibilities associated with preplanning.

Incident Commander. The IC's must ensure that planning meetings are planned for and conducted. They should schedule meeting time and location and notify those who are to attend. It is their responsibility to develop the general control objectives for the incident. The control objectives should not be limited to any single operational period, rather they should encompass the total incident. The IC's should develop a general strategy and state any major policy, legal, or fiscal constraints in accomplishing the objectives or appropriate contingency. They should ensure that the command staff is prepared to brief participants on liaison problems, safety considerations, and incident information releases.

Operations Section Chief. In conjunction with both ground and air supervisors the operations section chief must determine the need for additional resources, establish and define tactics, determine geographical, functional, and air assignments for the next operational period, determine need for staging areas and their location, and specify need for and location of other facilities such as camps, helispots, and resource drop points.

Planning Section Chief. The planning section chief must be prepared for a briefing on the current situation as relates to the incident, as well as resources and their status. The planning section must be prepared to interact with the operations and logistics section in developing appropriate parts of the action plan.

Logistics Section Chief. Logistics must be prepared to brief the team on support and service requirements of the incident, any problems associated with support such as communications, transportation, medical, feeding, facilities, and supply. This section must be prepared to interact with other sections, especially the air operations staff, for support and supply.

Finance Section Chief. The finance section chief must be prepared to brief on any cost constraints associated with the incident, problems with incident personnel time records, incident obligations and problems concerning agency financial policy. The section must be prepared to interact with other sections on all incident matters pertaining to finance.

Other Incident Personnel. In addition to the command and general staff other personnel may be requested to participate in the planning meeting to brief the staff on specifics of a particular specialty or problems associated with incident management.

Planning Meeting

The planning meeting is conducted by the planning section chief and is attended by the command and general staff along with other selected personnel. The primary purpose for this meeting is to prepare the action plan for the next operational period. With input from all of those in attendance, a sound workable action plan will emerge.

The meeting is conducted in a rather structured format, usually starting with a briefing by each of the section chiefs and others who are present. The incident commander may then brief the group on control objective, any constraints by the agency or line officer and possible competition for resources due to other incidents.

By using the operational planning worksheet (ICS Form 215), the planning process can be formalized and thoroughly documented. If the command and general staff have done a good job of preplanning, the formal process of completing the ICS Form 215 should take only a short time, even on complex incidents.

Form 215 is completed by the operations section chief and the planning section chief. Operations specifies work assignments by function and the resources needed to carry out those assignments. Planning completes the section on resources currently on the incident or that will be there to begin work at the beginning of the operational period. A process of mathematical computation determines what additional resources are needed.

The incident commander is responsible for developing general objectives for an incident.

The entire process must have input by the operations section (what is needed to accomplish the job), planning (what resources do we currently have and what is needed), logistics (can we meet logistical needs for the next operational period), and finance (what does it cost; is it cost effective). A key point here is that all members of the command and general staff must agree that they can support and implement the plan.

Postplanning Actions

At the conclusion of the planning meeting, all of the information necessary to complete the incident action plan should have been assembled. The planning section chief has the responsibility to complete the plan in a timely manner, generally specifying a time for each segment of the plan to be completed and ready for the incident commander's final approval.

At the completion of the planning meeting the logistics section chief will begin placing orders for additional overhead and resources as specified on the operational planning worksheet. The logistics section will also have portions of the action plan that must be completed and approved by the section chief.

After the incident action plan is approved by the incident commander the planning section chief is responsible for seeing that the plan is reproduced and distributed to appropriate incident personnel.

The ICS planning process provides for a timely, efficient, and easily documented series of events leading to an incident action plan that can be applied to any kind of emergency. ■

Protection of Archaeological Sites and Special Areas During Prescribed Burning

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For years now economic prescribed burning has been a concern of management. Protection of any special areas during burning can be costly and sometimes, if many interior control lines are required, resource damage can occur. This article presents one alternative that could be considered to protect certain areas.

During the planning process for a prescribed fire for wildlife habitat improvement, several problems out of the ordinary were encountered. The old field area to be burned was 50 acres in size and had some surrounding improvements. In addition to the improvements on the edge of the burn, there were several areas needing special attention.

First, there was a powerline (not charged at the time) that bisected the area. Along this line were the standard poles that support the line. Some precaution to protect the poles needed to be taken. Second, there were numerous known archaeological sites in the burn area. Whereas the sites inside the burn presented no particular difficulty, line construction was going to be a problem. Because of the frequency of known sites, movement of the control lines did not appear to be a practical alternative.

Existing natural barriers and changes in fuel types were taken advantage of as much as possible. The planning process considered roads and the change in fuel types, as well as the use of plowed line to the extent practicable. Still many chains of perimeter had not been dealt with. Because of the relatively gentle terrain along these chains, the idea of a foam line entered the plan.

Most firefighters have seen or at least heard of the Water Expansion Pump System (Texas Snow Job) tested and developed by the Texas Forest Service in 1978. In this unit compressed air serves as the propelling agent while the water pump is the force for the treated water. The compressed air is injected into the system on the discharge side of the pump and amplifies the treated water into foam. The treated water consists of a foam concentrate mixed with water to produce the foam.

The Warm Springs Ranger District of the George Washington National Forest had a setup similar to the Texas Snow Job and decided to evaluate it for the possible use of the wildlife habitat prescribed burn (fig. 1). The Model 30 slip-on pumper and Quincy 10-horsepower air compressor are

Figure 1—*Foam being applied as truck moves along edge of burn of known archaeological site.*

mounted on a 1-ton stake-body truck. The pump pressure was set at maximum with the engine speed set slightly above idle. The air compressor was set at 110 pounds per square inch (p.s.i.). The 125-gallon tank of water had to be treated with 1 gallon of commercial 3-percent protein foam concentrate mixture. In order to test the ability of the foam to last, weather readings were taken to assure durability given certain conditions (fig. 2). Conditions taken on site were as follows:

Dry bulb: 72°F
Relative humidity: 50 percent
Midflame wind: 3 mph
Partly cloudy

Past experience has shown that the foam stands up a little better under cooler conditions. These readings and tests were done 3 months prior to the burn, and temperatures were predicted to be a little lower during the actual burn.

With the above setting locked in we began the test. The preliminary results were as follows:

- Air pressure buildup time to 110 p.s.i. was 1 1/2 minutes.
- The application was 2–4 inches deep and 2 feet wide. (At this concentration the foam will hold a burnout for 30-40 minutes from the time it is applied.)
- The application time was 30 minutes for 1,600 feet or 24 chains.

Figure 2—*Foam that has been applied to hold burnout.*

At this point we encountered our next problem—we ran out of water/foam in the tank before we tied the lines in. We checked the fuel and it was not a problem; less than a quart had been used by the compressor and the same for the pumper.

To solve the water problem we decided to have a relay tank with treated water available. This would work but drafting through the hose would cost 12-15 minutes to time not affordable during line layout and burnout. The solution that was hit upon was the floating pump.

The Waterous Floto Pump (purchased from Wajax-Pacific Fire Equipment, Inc.) was tested to fill up the 125-gallon pumper (fig. 3). This pump was able to fill the tank in just under 2 minutes. Armed with this information we decided to place the pump in the relay tanker treated with the foam concentrate to refill the pumper.

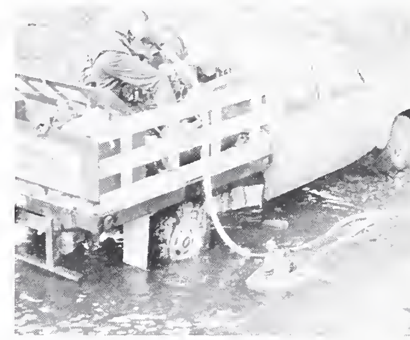

Figure 3—*Pumper being filled prior to burn.*

On the day of the burn, we utilized the pumper prior to ignition to foam the power poles to prevent any damage to them. Next, we located the relay tank with the floating pump at a location to refill the foam pumper when one tank expired. We were then ready to implement the plan.

Miraculously, the plan went off without a hitch, and the foam worked well. By utilizing foam the archaeological sites were not disturbed, the power poles did not burn, the amount of plowed line was reduced, and thus the amount of rehabilitation needed was lessened.

This technique is, by no means, a cure-all, but it does have some applications. Admittedly, terrain is the biggest obstacle; however, here in the South there are several areas this could be applied to. Although the idea is not new, the protection of archaeological sites with foam may seem kind of odd, but it worked out well for us. ■

Fire Policies and Programs for the National Park System [1]

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The fire management program designed for the National Park System (NPS) by the U.S. Department of the Interior, National Park Service, has experienced increasingly rapid change over the past two decades. The innovation of the 1970's is evolving into the professionalization of fire management during the 1980's. The segmentation of wildfire suppression from prescribed fire is giving way to a comprehensive approach of dealing with fire management as a whole. The ultimate objective, which has been attained in some areas already, is park fire management programs that are commensurate with the needs of park resources and in line with national policy.

Policy Evolution

The comprehensive fire management policies and programs of the National Park Service are the product of more than two decades of evolution. Before the 1960's, fire programs in the parks were based on suppression only. No one considered the contribution fires of natural origin may have made to the natural systems of the parks.

Today's comprehensive approach began with concepts expressed in the Leopold report (*2*) and that were first formally stated in the U.S. Department of the Interior's administrative policies (*5*). This approach recognized fires of natural origin as "natural phenomena" and also accepted prescribed burning as a means of achieving resource objectives.

The 1970's are best characterized as a period of innovation. Policy provided a broad conceptual guide for fire programs; managers and fire personnel had little guidance and few constraints. The result was a wide array of programs. Each program relied upon individual fire staff to develop the criteria and the processes by which programs would be managed. This innovation fostered many concepts that merged and crystallized in the 1970's. These concepts are evident in revisions of sections on fire in the management policies of 1975 and 1978 (*6, 7*). Their influence is also evident in the detail ultimately developed in the "Fire Management Guidelines," NPS-18 (*7*).

In the 1980's fire management is evolving into a mature and responsive program throughout the entire National Park System. A basic premise of this phase is that professionals within the parks will be trained to run the fire programs and will be trained to a level commensurate with the parks' needs. Our normal fire year programming (FIREPRO) is designed to provide that minimum level of decision capability.

In the National Park System, we manage natural areas and designated wilderness areas in the same manner. The resource concepts expressed throughout the management policies apply equally to portions of parks inside and outside of the congressionally designated wilderness (*8*). For the sake of simplicity, my references to parks in this discussion apply also to those natural areas and designated wilderness within parks.

Policy Evaluation

In 1968 the thrust was to awaken an otherwise methodical fire suppression program to the realities of natural area and wilderness needs. The administrative policies for natural areas were extremely terse in regard to fires and reflected the reaction to total suppression expressed in the Leopold report (*5*). The early research in Everglades National Park under Dr. Robertson (*4*) and in Sequoia and Kings Canyon National Parks under Dr. Hartesveldt (*1*) documented the need for change. It characterized fire as a natural phenomenon. It did not necessarily refute today's concept of fire management, but neither did it define how the concept of fire as a natural phenomenon should affect the management of individual parks.

The policy that developed was in keeping with Servicewide management philosophy at that time and

[1] Reprinted from Proceedings, Symposium and Workshop on Wilderness Fire, Missoula, MT, November 15–18, 1983.

permitted wide innovation. Many of the formally structured NPS handbooks were set aside during that period, and managers were given opportunities to adopt new programs for many aspects of park management.

This shift also fostered an increase in questioning by fire managers and researchers. In the early 1970's, policy was almost void of specific guidance regarding fire programs. Innovation took place in isolated parks and depended upon individuals, their training, expertise, and motivation. This fragmentation fostered both total inaction and exceptional accomplishments in parks.

In the early 1970's, the motivation and enthusiasm of some individuals eventually led to meetings of park and forest personnel who wanted an opportunity to exchange information and to seek answers and reinforcements for the isolated programs. It was recognized that there was a need for fire to be addressed appropriately in all parks in the System. This included not only the broad natural or wilderness areas but also the more numerous small and culturally based parks that make up the 334 units of the National Park System. These irregular aggregations of 20 to 30 fire staff members from the United States and Canada fostered and spread the basic concepts from which today's policy evolved.

Establishing Guidelines

In 1975 we completely rewrote our policies, from the standpoint of park management as well as fire management (*6*). The phase "management fires" was coined to characterize the contribution of prescribed burns and prescribed natural fires to park management. The phrase was understandable to the public but was dropped in the 1983 version in favor of the broad definition of prescribed fire as used by fire professionals. "Prescribed fire" is a contrast to "wildfires."

The most significant portion of the 1978 revision was that which specifically tied policy to park objectives. This change became necessary when the natural, cultural, and recreational management categories to which the earlier administrative policies had been tied were eliminated. In fire management especially, the broad concept of fire as a natural phenomena was put in the context of its appropriateness or inappropriateness, depending upon the blend of national policy and park management objectives (fig. 1).

Figure 1—*The appropriate use of fire as a management tool is described in the National Park Service's "Fire Management Guidelines."*

The policy was expanded upon in "Fire Management Guidelines," NPS-18 (*7*), the first complete instructions for park fire programs. These guidelines instructed superintendents to build a program commensurate with the needs of the park and provided a detailed policy that was to give all levels of management a consistent point of reference for fire management.

The greatest change in the latest revision (*8*) is the return to a classic sequence (prevention and suppression) followed by prescribed fire. A brief glossary is also included in an effort to eliminate confusion (*8*).

Unit Diversity

This policy spans a diverse National Park System and must therefore be coupled with much more specific objectives for each park if we are to truly perceive the proper role of fire management. Unfortunately, it is much more difficult to generalize about fire management applications. Fire management policy is best understood in reference to a specific park, where both the objectives for the park and specific parcels of land involved are known in addition to the policies themselves. The management zones within the parks include natural and wilderness zones. In addition, there are development zones and special use zones that may have significantly different fire management objectives. We are focusing here on the application of fire management to the natural and wilderness zones of the park, which are comparable to the designated wilderness of the National Forest System and the other agencies.

The numerous NPS units are diverse in size as well as vegetation. The physical area also influences the viable options available to park managers within fire management policy. Extensive areas such as Yellowstone National Park and the parks in Alaska provide a much wider range of management options than would be found in a small restricted natural park such as Muir Woods National Monument. Most areas fall between these extremes.

Whatever option is chosen, changing technology forces managers to continuously reassess the extent to which their programs can be adapted to achieve the optimum results described in the management policies.

Implications For Wildfire Management

Managers must also maintain an appropriate prevention and suppression capability to respond to wildfires. The suppression program is necessary to prevent unacceptable modification of these extensive natural systems by modern society. There *is* a major threat posed by the ever-increasing number of visitors—almost 250 million in 1982. A continuing awareness by management is needed to avoid unwanted human-caused wildfires.

Suppression programs are designed to minimize the size of wildfires and their impacts. Although the Service now uses the least damaging suppression technique, unfortunately we still have examples of disturbance associated with suppression action on old wildfires. This disturbance is more visible today, several decades after the fire, than is the impact of the wildfire itself. High-impact suppression techniques are no longer acceptable.

Prescribed Natural Fires

The policy regarding "prescribed natural fire" epitomized our fire management in wilderness. Although many questions have been raised about the phrase, the concept persists. The Service develops prescriptions for various fire management units before natural ignitions—primarily from lightning—occur. This process allows the Service to carry out natural area management with a minimum investment in research and simultaneously to avoid continued suppression impacts. It also provides the maximum opportunity to attain natural diversity and eliminates most of the arbitrary human decisions on these fires. Where parks are unable to use this technique because of extremely restricted geographic boundaries,

prescribed burns can be substituted for prescribed natural fire within the specifically approved park plan. Programs are continuously reviewed as the state-of-the-art changes and further refinements permit more parks to attain their objectives of natural systems management.

The policies of the National Park System are designed to establish an attainable management program based on reasonably valid criteria. In many cases, this is feasible without intensive research into the precise effects of fire on all species. At least progress can be made in the right direction. As time and resources permit, the programs can be refined to more precisely achieve the desired objectives.

This approach also permits limited research dollars to be directed to crucial common issues, such as exotic or endangered species, fire behavior, and meteorological research. Advances in these areas would permit us to further refine the prescriptions and their reliability. For example, if lightning occurs within a park, there is obvious potential for the natural role of fire. No research is needed because the potential for lightning fires is obvious.

Programs

The fire management program described here is intended to be all encompassing, covering the full range of options from prevention, presuppression, suppression, and the use of prescribed fire where it contributes toward park objectives. The capability to carry out such a program rests upon two essential components. Knowledgeable staff is the first and foremost of these. The staff must have adequate knowledge of fire behavior, the equipment associated with fire, and the relationship of fire to the resources of the park in order to guide the program toward the objectives.

The second component is support by technology. In the past, the intuitive judgment of individuals was the major component of fire management, complemented by fire equipment. Today, supporting technology, particularly in the field of fire behavior and computer modeling, is rapidly increasing both in complexity and volume and plays a far more significant role. This technology places an additional burden on the staff to remain knowledgeable but also provides that staff with greatly expanded capability.

To keep in context the diversity found within the National Park System, we might examine the present array of parks being incorporated in FIREPRO. We adapted the normal fire year planning process of other agencies to the particular needs of the National Park System. Our version, FIREPRO, joins constrained operations analysis to the budget formulation process. It is operational in 16 parks and in the regional and Washington offices. Our goal is to expand to include the full 202 parks where wildland fire occurs.

Table 1 shows that most parks are relatively small and have limited fire management programs.

Table 1—*Complexity levels of National Park Service emergency presuppression programs.* [1]

Complexity levels	Number of parks
Level I	160
Level II	28
Level IIA	6
Level III	8
Total	202

[1] The levels, from I to III, reflect an increase in complexity of emergency presuppression programs.

Only eight parks are at level III, at the upper end of the spectrum; they have highly complex programs, large geographic areas, and high fire occurrence and potential. Future program refinement and maturation will take place primarily in the large aggregation of less complex level II parks. Most of these parks have full suppression programs and fairly modest fire occurrence. Many will need to reassess fire causes and influence and their fire management objectives and to revise their fire management plans accordingly. The simplest programs are level I, which have low fire occurrence and low potential. However, the people

managing these programs also tend to get in trouble the fastest in exceptionally bad years because of their limited experience with fire.

Wildfire

Much of our emphasis in fire management is on the application of prescribed fire. Without the undergirding of an effective prevention and suppression program, however, the National Park Service will not be able to achieve the objectives for which these parks were set aside. The natural influence of fire on the system is meaningful only to the extent that those systems have not been upset by modern humans. To assure that human effects remain limited, both personnel and equipment must always be ready to combat wildfires.

Hundreds of thousands of people visit even the remote portions of national parks. National parks received overnight use of about 2.5 million camper days in 1982. The percentage of human-caused annual fire occurrence varies considerably among parks; however, the national average based on our FIREPRO analysis indicated that 63 percent of fires are human caused.

FIREPRO implementation in a park involves such technologies as the use of AFFIRMS and the TI-59 calculator to run fire behavior and planning models. The computer terminals many parks now have will play a greater role in future weather analysis and planning. The access to this type of information is basic to sophisticated management. The other equipment and supplies essential to execute these appropriate fire programs at the park are also defined by FIREPRO analysis. Slip-on water expansion units, engines, and fire cache contents, such as the basic shovels and flappers, complete the physical capability.

The fire arena can be expanded to include park neighbors through interagency agreements. In Yellowstone National Park such agreements are the key to mutual aid on wildfires. They also provide for prescribed natural fires to cross boundaries if such practices are mutually agreeable.

The suppression program, with its training, decision capability, data base, and equipment, is an integral facet of the management of the park ecosystems. It provides a sound technical basis for protection of park resources and a foundation upon which to build prescribed fire applications.

Prescribed Fire

Those personnel that oversee the fire management program must have enough experience to know what fire does before they attempt to adapt it to specific objectives. The intelligent use of prescribed fire rests upon two tough management decisions. The first is whether prescribed fire is desirable and feasible. The second is determining where, when, and how prescribed fire can achieve the desired objectives.

We have the opportunity to use the computerized fire behavior modeling and analysis to assess park needs and design prescriptions. Wildfire occurrence and behavior can also give us information needed to build or refine prescriptions.

Complex fire management programs carry with them additional obligations. An effort must be made to assure continuity of qualified staff because park and wilderness management entails the care of these areas through this and future generations.

Guidelines provide technical information necessary for prescribed burn programs and identify the best possible course of action for the park. Everyday management concerns often make it easy to ignore critical facets of burn plan execution, particularly in an impatient push for results. We have all seen this happen with prescribed fires. We must avoid initiating a burn just to get it over with and must follow the carefully developed prescription even if it means canceling costly preparations. The proper results are paramount, not the schedule.

Our prescribed fire program has two broad categories—prescribed

Our prescribed natural fire program permits us to end the arbitrary full suppression policy for fires of natural origin . . .

natural fire and prescribed burns. Prescribed natural fire is our primary program in natural zones and wilderness.

Prescribed natural fire—The natural systems associated with the parks should determine the distribution, intensity, and timing of the fires. A lightning storm may produce a variety of lightning strikes (fig. 2). Which of these strikes begin fires and ultimately affect the vegetation is determined by an extremely complex aggregation of vegetative and atmospheric factors. We do not ever expect to obtain enough scientific data to enable us to exactly replicate that process. In the absence of that capability, planned management constraints, in the form of fire prescriptions, are the only feasible means to effectively manage natural fire effects. These constraints include such factors as the geographic limits to fire spread, the intensities we feel we can adequately manage, and, obviously, such overriding considerations as the protection of human life and property. Such prescriptions may be much briefer than those for prescribed burns, but they are prescribed long before ignition occurs.

Our prescribed natural fire program permits us to end the arbitrary full suppression policy for fires of natural origin that previously applied to extensive park areas. As more is learned about the various effects of fire,

Figure 2—*Lightning-caused fires are managed as part of the prescribed natural fire program of the National Park Service.*

we may be able to further expand the prescribed natural fire program into other areas of parks.

Prescribed burn program—Our prescribed burn program, which includes all forms of deliberate ignition of prescribed fires, is much more detailed and much more restricted geographically than the prescribed natural fire program. Only a dozen or so parks are involved. We permit prescribed burns within the natural areas and in designated wilderness, primarily to restore natural fuel loadings, but only under carefully constrained conditions and according to specific burn plans for a park or subunit.

We hope that using prescribed burns to restore natural fuel loading is a strategy we will be able to phase out. In a park that has a fuel load 50 percent above what would normally have occurred in the absence of past suppression, the objective of prescribed burns would be to reduce that fuel loading by 50 percent. If this reduction were accomplished by one or two prescribed burns over most of the area, that segment of the park could then be reclassified as a prescribed natural fire unit and further arbitrary prescribed burns would no longer be used.

A second use of prescribed burns is to reduce hazards along park boundaries where no agreements exist to allow prescribed natural fires to cross them. The reduced fuel zone helps protect adjacent private properties and also helps us prevent the spread of wildfires from surrounding areas into the natural system.

Another facet of hazard reduction is in and around developed areas within the parks. The presence of large volumes of fuel within developments makes it virtually impossible to effectively deal with fire hazard, let alone prescribed natural fires on adjacent wildlands. Fires could not be prevented from spreading to those developments and destroying them or endangering the occupants. Prescribed burning in and around

developments to reduce the fuel accumulation may permit us to improve protection and to increase the size of the adjacent prescribed natural fire units.

Last, prescribed burns are used in limited areas to physically manipulate the park vegetation, particularly if we determine certain species are being lost due to the absence of fire, and no other alternatives, such as prescribed natural fire programs, are feasible. Prescribed burns are also used in our cultural and recreational parks where we have purposes other than maintaining pure natural systems. We might manipulate the vegetative cover to perpetuate fire subclimax species, such as pines in the southeastern United States or open fields on battlefield sites to mimic the historic setting.

In all cases of the prescribed fire program, we are fully capable of suppression action should any fire exceed its prescription. This includes reacting with forces on the ground as well as forgoing prescribed burns and, when extreme fire danger exists, rapidly suppressing what would otherwise be prescribed natural fires. These tactics are especially important when wildfire suppression forces have already been overtaxed locally or nationally.

All prescribed fires that exceed prescriptions are reclassified as wildfires and remain so classified until they are out. We categorize wildfire management according to levels of intensity: management that confines, contains, or controls, in increasing order of aggressiveness. These criteria are also used by the U.S. Department of Agriculture, Forest Service; similar fire management programs are evolving in other Federal land management agencies.

Conclusion

The past decade has been marked by rapid change (for a bureaucracy) in policy and programs; the intent has been to guide and support park fire programs. This effort was facilitated by tying park resource objectives to national policy and programs.

In "Megatrends," John Naisbitt (*3*) characterized the process when he said "the richness of the mix always results in creativity, experimentation, and change." Fire management over the past decade has been rich in the number of highly motivated individuals, agencies, and disciplines involved. The resulting changes have yielded quality programs.

FIREPRO will enable us to carry out our fire management program. It will assure continuing capacity for decisionmaking in the parks and will provide the personnel and equipment needed to execute the programs. The options available to the manager in each and every park with natural systems and wilderness will be adequate and realistic.

The goal of NPS policies and programs is comprehensive fire management—a totally integrated application of suppression and prescribed fires to attain park objectives. To use a cliche, a chain is only as strong as its weakest link. The National Park Service strives to assure that all links in this comprehensive program are adequate to assure implementation of quality fire management in the natural systems of the parks and their designated wilderness.

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Documentation of the Incident Command System

Don Halsey, Jim Whitson, and Marv Newell

Chief, Division of Training, USDI Bureau of Land Management; Staff Specialist, FIRETIP Project, USDA Forest Service; Staff Assistant, FIRETIP project, USDA Forest Service, Boise Interagency Fire Center, Boise, ID.

The Incident Command System (ICS) is designed to be used in response to emergencies caused by fires, floods, earthquakes, hurricanes, tornados, tidal waves, riots, spills of hazardous materials, and other natural or human-caused incidents. The ICS is the organizational component of the National Interagency Incident Management System (NIIMS) for management of wildland fire incidents. Current documentation consists of the ICS operational system description, position manuals, general instructions to ICS supervisory personnel, glossary of terms, ICS forms manual, NWCG fireline handbook, and the wildland fire qualification guide.

Job Performance Requirements

Though generally complete, documentation of the ICS does not include data sufficient for system or position evaluation. Job performance requirements (JPR's) have been developed by the National Wildfire Coordinating Group (NWCG) Incident Command System Working Team to fill in this gap.

Job performance requirements were developed for section chiefs, unit leaders, and many of the subordinate ICS organization positions in the command, operations (ground and air), planning, logistics, and finance sections. The documentation for a JPR identifies a work production, the conditions to be met enabling job performance to produce the product (conditions including tools, equipment, and resource information), standards or degree of accuracy to be met in producing the end product, critical sequential jobs/tasks required to produce the product, and contingencies for relating to the unknown, such as blowup fire weather conditions. A number of products are produced by each of the ICS positions. The products of positions, collectively, are the products of job performance required to manage a wildland fire incident.

JPR's are based on a job inventory which describes the tasks involved in wildland fire incident management. Much of the job inventory data is in the current ICS documentation. The JPR's enable objective evaluation of the ICS and complete the level of documentation required to manage the system.

Standards identified in the JPR's are in most cases minimal. Most users would expand them to relate to local agency operations. These standards form the base level of guidelines to make the system performances observable and measurable.

JPR's can be used in many different ways by several different groups, including the following:

A. Agency Managers and Supervisors

1. Make comparisons between defined jobs. For instance, a State organization can relate its wildfire incident management jobs to similar jobs in other agencies.
2. Develop a fire incident management organization within an agency; for example, develop job descriptions and assign the right people to specific jobs.
3. Identify the detailed tasks needed to accomplish the products of wildland fire incident management.
4. Develop job aids.
5. Evaluate job performance; formulate a measurement of actual performance against the standards of work established in the JPR's.

B. Training Program Managers

1. Analyze training needs of the individuals and the organization.
2. Develop performance testing and training systems.
3. Develop training materials.

C. Individual Employees

1. Define job requirements to include expected products, actions, conditions, and standards; tell the employee what to do, how to do it, under what conditions to perform, and what will constitute successful completion.

2. Describe organizational relationships, both interorganizational and intraorganizational functional roles.

3. Establish a source of pertinent job performance aids and references.

All of these JPR's will be packaged and available to the agencies through the NWCG Publication Management System.

With completed documentation and a position and incident evaluation process, a cycle of validations and checking begins. For instance, the job inventory may not have been complete or accurate. Further work may be required, leading to one or more new JPR's. Followthrough will be needed to carry the information into performance tests and training support materials.

With the completion of the system documentation and validation, the next logical step is development of a true performance-based qualification system. Agency and NWCG leadership will be necessary for this development. ■

Thirteen Situations That Shout, "Watch Out!"

1. You are building line downhill toward a fire.
2. You are fighting fire on a hillside where rolling material can ignite fuel below you.
3. You notice the wind begins to blow, increase, or change direction.
4. You feel the weather getting hotter and drier.
5. You are on a line in heavy cover with unburned fuel between you and the fire.
6. You are away from burned area where terrain and/or cover makes travel difficult and slow.
7. You are in country you have not seen in the daylight.
8. You are in an area where you are unfamiliar with local factors influencing fire behavior.
9. You are attempting a frontal attack on a fire with mechanized equipment.
10. You are getting frequent spot fires over your line.
11. You cannot see the main fire, and you are not in communication with anyone who can.
12. You have been given an assignment or instructions not clear to you.
13. You feel like taking a little nap near the fireline. ■

Research Publications Listing

Forest Fire and Atmospheric Sciences Research has available their 1984 publications listing of forest fire related research publications. A copy of this list is available from USDA Forest Service, Forest Fire and Atmospheric Sciences, P.O. Box 2417, Washington, DC 20013.

Don't Forget It!

Gladys Daines

Smokey Bear Program Manager, USDA Forest Service, Cooperative Fire Protection, Washington, DC.

Arson is on the rise in our wildlands. Nationally, arson has increased from 24 percent in 1973 to 31 percent of all wildfires today.

Arson, the leading cause of wildfire in the South, causes 60 percent of Southern wildfires. Trash burning and carelessness account for 38 percent, and lightning causes 2 percent.

Between January 1 and April 30, 30,477 wildfires burned 418,500 acres in the Southern States. During one 12-day period in April, wildfires in the South burned 275,075 acres. These fires caused 8 fatalities and 179 serious injuries. In North Carolina alone, property damage was listed as $4.5 million.

The Cooperative Forest Fire Prevention (CFFP) program has been increasingly concerned about the rise in arson-caused wildfires. The CFFP program, in conjunction with the Ad Council and State Foresters, began specific efforts against arson 3 years ago with a Smokey Bear poster featuring a red touch tone telephone that carried the slogan "Punch out an arsonist." Newspaper and magazine public service ads followed with the message, "A forest fire is a shame, starting one is a crime." Last year, a radio public service ad told a story about how a campfire got away and the responsible person had to pay $100,000 for being careless with fire.

The hard-hitting public service ad "Criminal" is designed to have an impact on arsonists and people careless with fire.

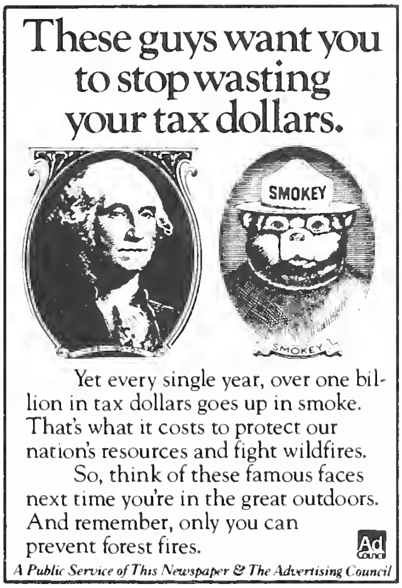
"Criminal," the 1985 television public service ad, is aimed specifically at arsonists and careless people. Most people are unaware of the laws and penalties regarding wildfires started by people. "Criminal" is a hard-hitting message. The public was not expecting it, which is exactly the reason "Criminal" was made. This public service ad was designed so that people would not forget the spot after they had first seen it. The forcefulness of the presentation will make viewers remember that "if you're guilty of starting a forest fire, even accidentally, you'll pay for it."

"Criminal" has received a lot of donated television air time across the country. In the first 2 months of playing time, only two people contacted the CFFP office with negative comments—a letter from Arizona and a phone call from Texas. Both of these individuals will remember seeing the 1985 TV spot. And now that we have answered their questions, they understand the need to reach arsonists and careless individuals.

The 1985 television public service ad has stimulated many calls from newspapers and from television and radio stations across the country. These callers requested

information and live interviews that have produced a swell of national interest in the Smokey Bear program. Through these activities, the program is reaching more people than ever before.

Smokey Bear's campaign goes on—to children who need to learn about forest fire prevention and adults who need to be reminded that, "Remember, only you can prevent forest fires." ■



Two public service advertisements from the 1985 Cooperative Forest Fire Prevention Campaign.

Aerial Ignition Device

G.W. Hildreth

Fire Control Officer, New Zealand Forest Service, Nelson, New Zealand.

In New Zealand all under-helicopter burning equipment must be made to standards set by the Civil Aviation Department. All burners are given a serial number and are checked annually.

The burner I have made is safe to operate, easy to control, and not expensive to build (fig. 1). Safety must be the most important consideration when making and using this type of burner.

The burner is made up of four main sections:

1) Tank,
2) Ignition circuit,
3) Pump control, and
4) Fire extinguisher system.

Tank

The tank is rolled from 3-millimeter mild steel plate. It is pressure tested to 24kpa according to a standard set by the Civil Aviation Department.

The tank vent, which is fitted with a spark arrester, is located at the front of the tank. The filling tube is positioned away from the burner nozzle so that any spill cannot be ignited by fuel still burning up in the outlet nozzle.

The cover that is under the burner and the back hinged cover prevents any flame from burning wiring and hoses.

Ignition Circuit

The spark is provided by an electronic spark unit connected to a 12-volt car coil. A vehicle spark plug ignites the jelly petrol as it comes from the outlet valve. The cover around the spark plug prevents the plug wire from being burned.

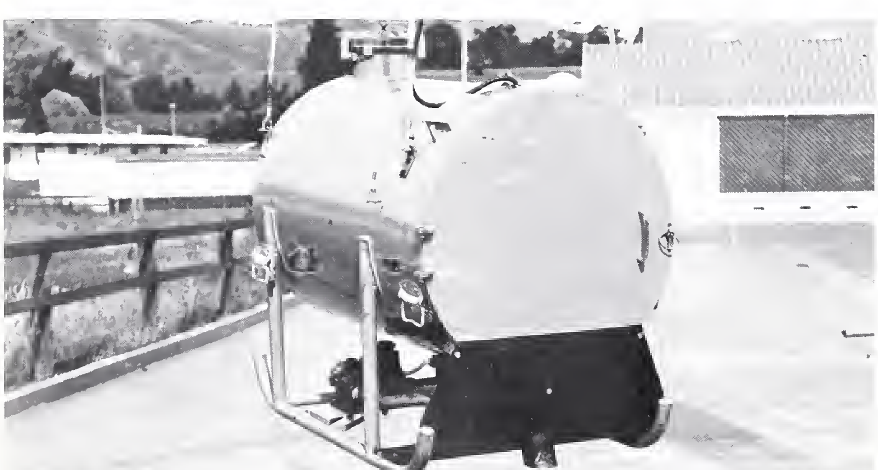


Figure 1—*Aerial burner developed in New Zealand.*

The spark system can be isolated at the burner if the pump flow is to be tested without igniting. The burner is tested after lifting off from the control area, and the extinguisher discharge cleans the spark plug. This technique saves landing and clearing the plug by hand, which could cause a break in light-up pattern.

Pump System

As the tank is not pressurized the pump is a self-priming fuel pump (fig. 2). It is capable of pumping petrol without affecting the impeller and housing.

An outlet valve is located at the burner nozzle and shuts off when the pump stops. This prevents burning fuel from dribbling out when the unit is turned off, which could light up areas that are not to be burned. An inline stainless steel fuel filter is fitted between the tank and the pump, also acting as a flame arrester.

The operator in the helicopter has full control over the burner and can alter the application rate to give a fuel flow from 1 liter a minute up to 26 liters a minute. The flow rate is determined by the conditions and type of fuel being burnt.

Fire Extinguisher System

I feel all helicopter burners should have some system for extinguishing the burners at the outlet

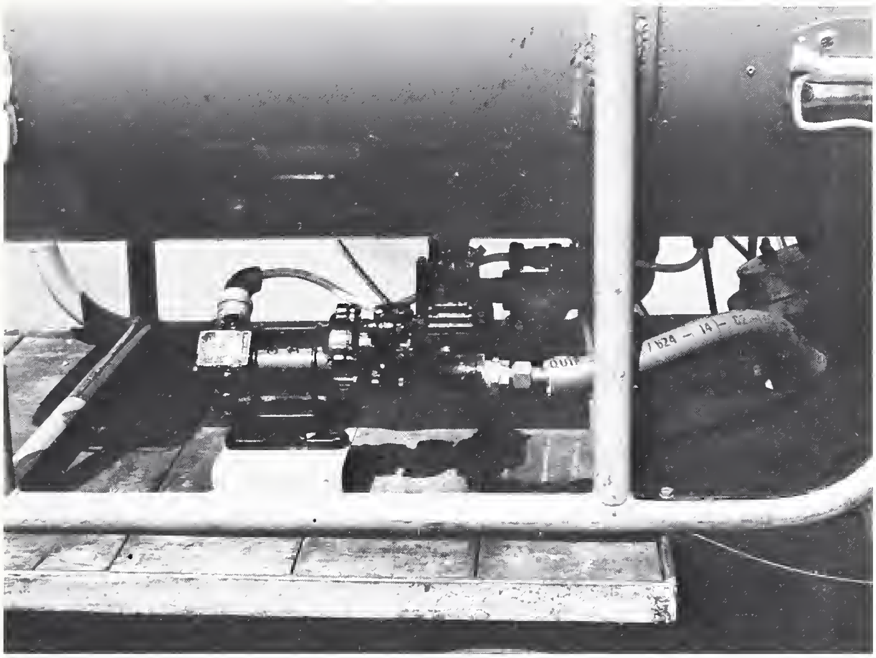


Figure 2—*Pumping system.*

nozzle during flight (fig. 3).

This burner has a 3.5-kilogram carbon dioxide bottle attached to the burner nozzle at 4,000kpa. This puts out any burning jelly petrol that is caught in the nozzle. Some accidents have occurred when the tank has overfilled and the jelly petrol has come in contact with flame still present up in the burner nozzle.

As the fire extinguisher is only operated for about a second each time, the carbon dioxide bottle lasts about 5 hours. Nevertheless, a spare unit is taken to each burn. The operator in the helicopter activates the fire extinguisher by pressing a pushbutton on the control box (fig. 4).

Figure 3—*Equipment layout.*

Figure 4—*Helicopter control unit.*

Fire Lighting Specifications

- *Maximum weight*—238 kilograms.
- *Maximum fuel quantity*—180 liters.
- *Fuel*—Aluminum stearate and petrol.
- *Mixture rate*—1 kilogram aluminum stearate to 54 liters petrol.
- *Power supply*—24 volts negative earth.
- *Fire extinguisher*—3.5-kilogram carbon dioxide.
- *Fuel system*—24-volt fuel pump.
- *Fuel flow rate*—1 liter per minute up to 26 liters per minute. ■

The Ground Fire Sprinkler: A New Firefighting Tool

Douglas J. Riley

Park Ranger, USDI National Park Service, Delaware Gap National Recreation Area, Buskill, PA.

Deep-seated ground fires can be difficult to extinguish, particularly when the fires occur in very rocky organic soils. The two basic methods of combating deep-seated ground fires are trenching and deluging. However, both methods have drawbacks. Trenching can be very expensive in terms of both work hours and equipment, and many times the environmental damage caused by trenching can far exceed the damage that the ground fire would have done. Deluging can also be quite expensive in terms of both work hours and equipment, and if not done properly it can also cause severe environmental damage.

Keeping these factors in mind, Park Ranger Doug Riley, working in cooperation with representatives of Rainbird Sprinkler Systems, has developed a new type of sprinkler to be used in combating deep-seated ground fires (fig. 1). This new type of sprinkler will wet down a circle 120 feet in diameter with five-eighths of an inch of water/hour. A small 2-cycle portable pump such as the Homelite XLS 1 1/2 will provide enough pressure and water to operate one of these sprinklers, whereas a large 4-cycle pump such as the 11-horsepower Homelite will provide enough pressure and water to operate three of these sprinklers.

The *basic* specifications for the new sprinkler are as follows:

Sprinkler head (fig. 2): Rainbird

Figure 1—*The new Rainbird sprinkler was designed to help combat deep-seated ground fires.*

Figure 2—*Rainbird sprinkler head.*

Initial testing of the prototype sprinkler model, utilizing a Homelite XLS 2-1B centrifugal pump, yielded the following results:

Hose size (inches)	Length (feet)	Diameter of wet circle (feet)
1-1/2	50	100
1-1/2	100	124
1	100	120
1	200	92
1-1/2	50	
combined with		108
1	100	
1-1/2	100	
combined with		118
1	50	
1-1/2	100	
combined with		88
1	200	

80E TNT: 7/16- and 7/32-inch nozzles, length 11.5 inches, weight approximately 4 pounds.
Standpipe: Black iron pipe (1 1/4 inch in diameter): Length 36 inches, weight approximately 5 pounds.
Base fitting: Galvanized iron (1 1/4 inch in diameter): Length 8.75 inches (including 4.25-inch stabilizing spike), weight approximately 2 pounds. *Note*: This base fitting is plugged at one end (spike end) and is fitted with a 1-inch NPSH inlet.

Tripod: Black iron pipe (one-half inch in diameter): Length 50 inches (including a 4.25-inch stabilizing spike on the bottom of each leg), weight approximately 12 pounds. *Note*: This tripod is fitted with a lock collar so that it can be adjusted to varying heights.

The height of the sprinkler unit (excluding the tripod which, when properly adjusted, does not add to the overall height) is approximately 4 1/2 feet, not including the stabilizing spike.

Additional testing of the prototype model utilizing an 11-horsepower Homelite 4-cycle pump yielded much the same results, except that the pump provided enough pressure and water to operate three sprinklers, whereas the smaller 2-cycle pump could provide enough pressure and water to operate only one sprinkler. The Rainbird 80E TNT sprinkler, when equipped with 7/16- and 7/32-inch nozzles, *under ideal operating conditions*, (utilizing standard aluminum irrigation pipe to supply the

water), requires 70 p.s.i. to produce a wet circle diameter of 160 feet, laying down 40 gallons per minute when operating at maximum efficiency.

The only changes that were made in the prototype model were strengthening the overall construction of the sprinkler and improving its stability. (The prototype had an aluminum standpipe and an aluminum support, both of which were found to be too susceptible to damage when used under actual field conditions.) These changes seemed to make little difference with regards to sprinkler output in terms of wet circle diameter or water output.

These sprinklers could be used to establish a wide-diameter wet line around a deep seated ground fire, or they could be used to saturate the area in which the ground fire is located, while at the same time maintaining a wide-diameter wet line around the fire. Proper utilization of these sprinklers when combatting deep-seated ground fires should improve the overall efficiency of this type of fire management operation and should, in the long run, greatly reduce the number of work hours and the amount of money that is spent on extinguishing this type of fire. ■

Recent Fire Publications

Alexander, M.E. Prescribed fire behavior and impact in an eastern spruce-fir slash fuel complex. Canadian Forest Service Research Notes. 4(1): 3–7, 25; 1984.

Bacon, Warren R. and Dell, John. National forest landscape management, volume 2. Agric. Handb. 608. Washington, DC: U.S. Department of Agriculture, Forest Service; 1985. 89 p.

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Pyne, Stephen J. Introduction to wildland fire: Fire management in the United States. New York, NY: John Wiley and Sons; 1984.

Steele, Robert W. and Barney, Richard J. Bulldozers in fire management: current designs and uses. Res. Note INT-328. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1983. 4 p.

Terry, Bill. The ABC's of wildfire control. TF News. College Station, Texas: Texas Forest Service; Winter 1984; 63. ■

Improve Your Wildland Fire Knowledge

Utah State University will be offering a series of four 2-week courses on various wildland fire topics during the current academic year:

- Module I—October 21 to November 1, 1985: Wildland Fire—Fire Ecosystems and Fire Effects
- Module II—January 6 to January 17, 1986: Fire Data and Information Systems
- Module III—April 28 to May 9, 1986: Economics of Fire Management Systems
- Module IV—August 4 to August 15, 1986: Fire Control and Use

USDA Forest Service employees will lecture along with other recognized fire personnel. You will find it an opportunity to bolster your skills in one or more of the above areas. A brochure and registration form may be obtained from:

Michael Jenkins
Department of Forest Resources
College of Natural Resources
UMC 52
Utah State University
Logan, Utah 84322
Telephone: (801) 750-2455

Test Results of Fireline Blasted With Explosives

Explosives have long been considered a possible tool for fireline construction. Unfortunately, little information has been available to compare the quality and the cost of blasted fireline to conventional methods such as hand crews or bulldozers.

Research Forester Richard J. Barney at the Intermountain Station's Northern Forest Fire Lab in Missoula, MT, describes characteristics of blasted fireline in a recent study. Two types of linear explosives were compared in heavy, moderate, and light fuel cover. Barney found slight differences between the two explosives, but concludes that both can create, after light cleanup, effective firebreaks.

Future research will assess characteristics of blasted fireline in other cover types and provide cost comparisons between blasting versus conventional construction methods.

If you would like more information on this study, request "Characteristics of Fireline Blasted with Linear Explosives: Initial Test Results," Research Note INT-345. Please write to the Intermountain Forest and Range Experiment Station, 507 25th Street, Ogden, UT 84401. ■

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